Looking at Host Galaxies / Residuals with the Maraston SED Models (in progress)

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with Janine Pforr, Bob Nichol, Hubert Lampeitl, Claudia Maraston & SDSS-II

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First Up
The Original Host Galaxy Analysis

- The First Host Galaxy Paper is now "complete"
- It's made it to the internal review stage
- Many thanks to John Marriner
- With helpful comments (to date) from David Cinabro, Jesper Sollerman, Don Schneider and others
- Everybody is welcome / encouraged to sign up!
- Some (minor) improvements on the way in the next week or two

- A full description of "fun" systematics with PEGASE
- Hopefully complete very soon

Hosts Galaxies of Type Ia Supernovae in the SDSS Supernova Survey

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ABSTRACT

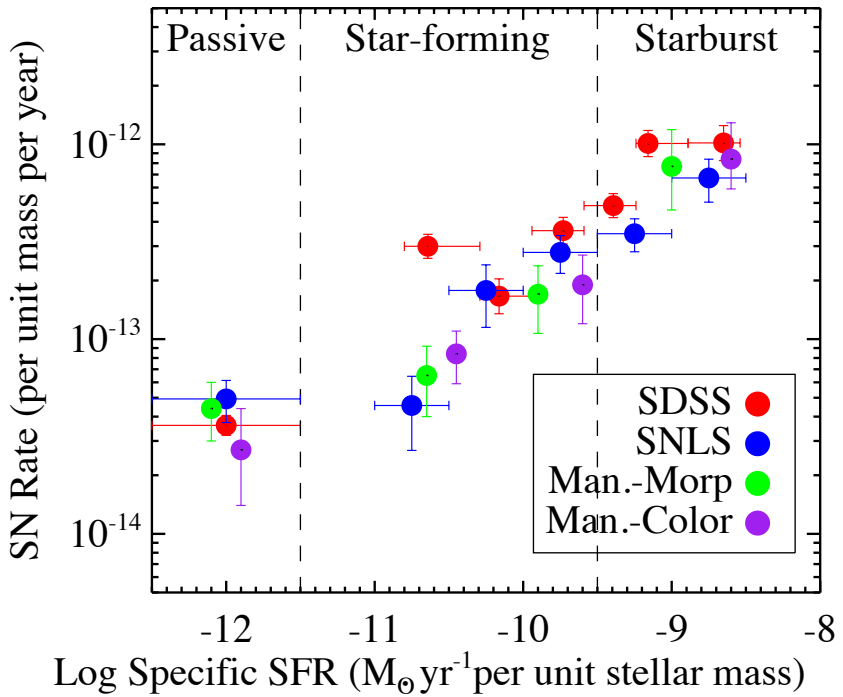
Using data from the completed Sloan Digital Sky Supernova Survey (SDSS SN Survey), we investigate the rate of Type Ia Supernovae (SNe Ia) as a function of galaxy properties. A sample of 342 SNe Ia with $z < 0.25$ is used, including of 197 (58%) SNe Ia which have been spectroscopically confirmed and 87 (25%) have been identified by their light-curves but have a spectroscopically measured redshift of the host galaxy. The remaining SNe Ia are identified through their light-curves and have a photometrically determined redshift. We find that the rate of SNe Ia in passive galaxies is far lower than that in star-forming galaxies and that the SNe Ia rate depends strongly on the amount of recent star formation. When the host galaxies are characterized by a stellar mass (M) and the recent star formation rate (SFR), the SN Ia explosion rate (SNR_{Ia}) is well described by $SNR_{Ia} = A \times M^{n_M} + B \times \dot{M}^{n_{SFR}}$ with $n_{mass} = 0.674 \pm 0.149$, $n_{SFR} = 0.957 \pm 0.074$, $\log A = -10.01 \pm 0.67$, and $\log B = -2.82 \pm 0.04$ (statistical errors only). Our analysis follows closely the analysis of Sullivan et al. (2006) who analyzed the high redshift data from SNLS. While our results are similar to those of Sullivan, one notable difference is that we find $n_{mass} < 1$ while the best fit found by Sullivan was $n_{mass} = 1.00^{+0.11}_{-0.10}$ and $n_{SFR} = 0.98^{+0.12}_{-0.11}$. We also compare the MLCS SN light-curve parameters Δ and A_V for passive, moderately star-forming, and star-forming galaxies. The Δ parameter is different in passive galaxies but similar in moderately and strongly star-forming and galaxies. The A_V parameter is similar in passive and moderately star-forming galaxies, but appears to be somewhat smaller, on average, in heavily star-forming galaxies.

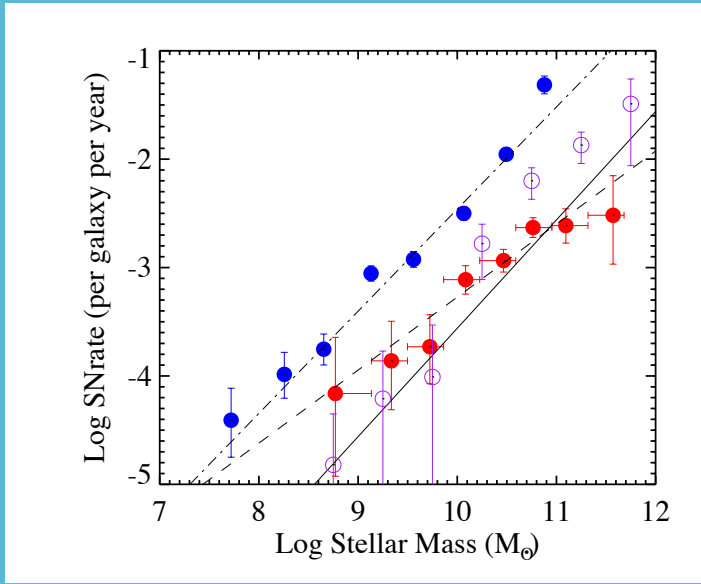
Subject headings: type Ia supernovae; cosmology; galaxies

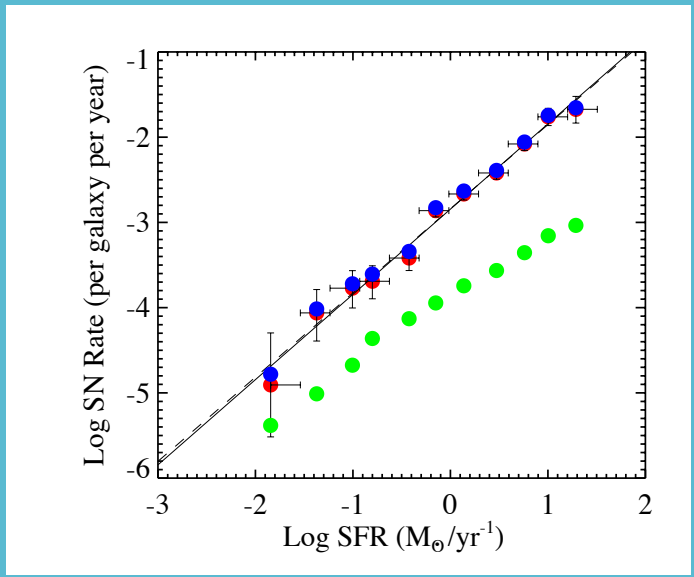
For those that missed it ….

We looked at SNe Ia rates as a function of :

- host galaxy type
- stellar mass
- (recent) star formation rate



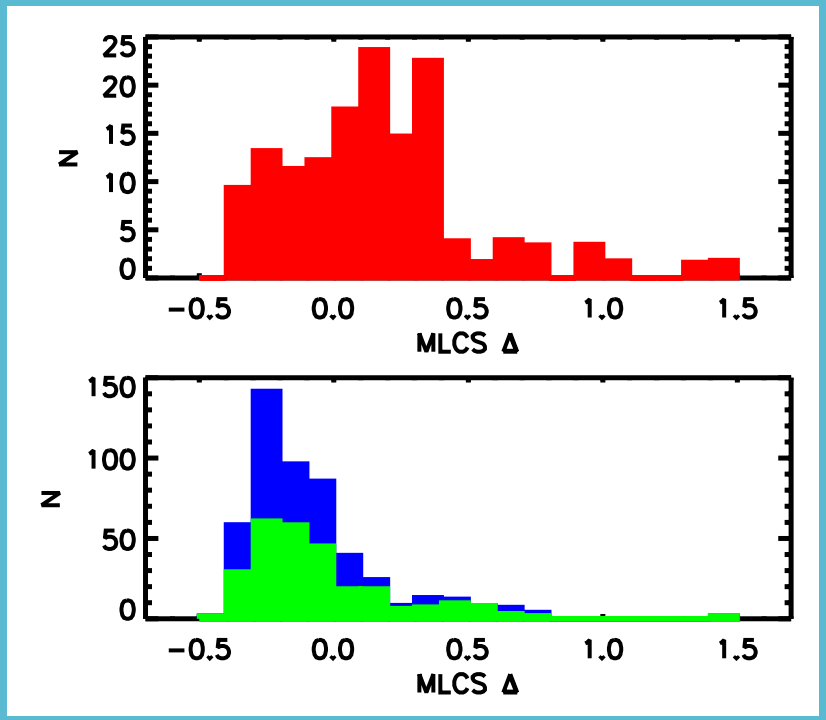


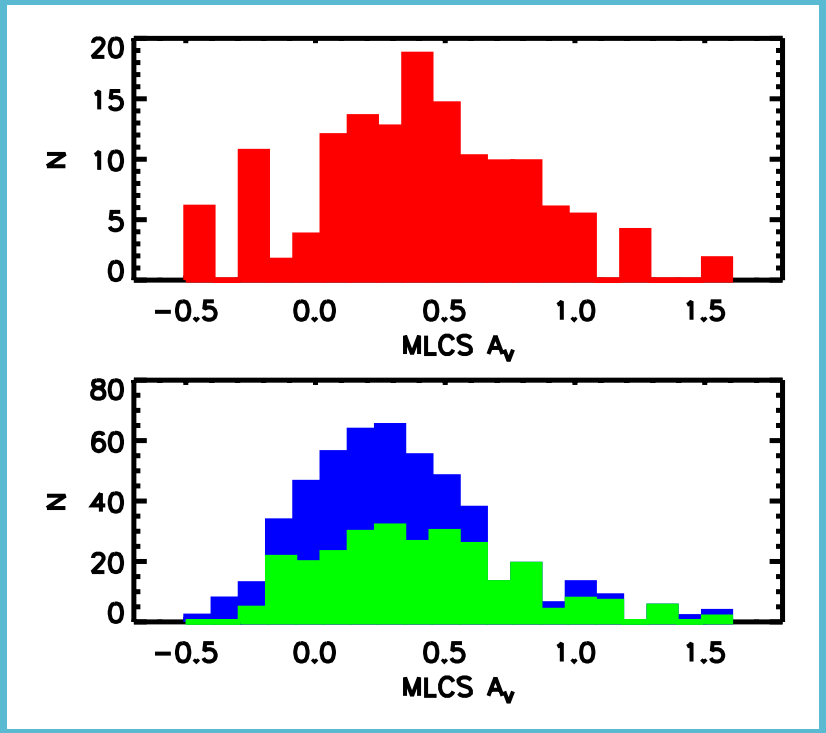


For those that missed it (2) …

We also looked at SNe properties:

- Extinction / reddening
- Delta / stretch



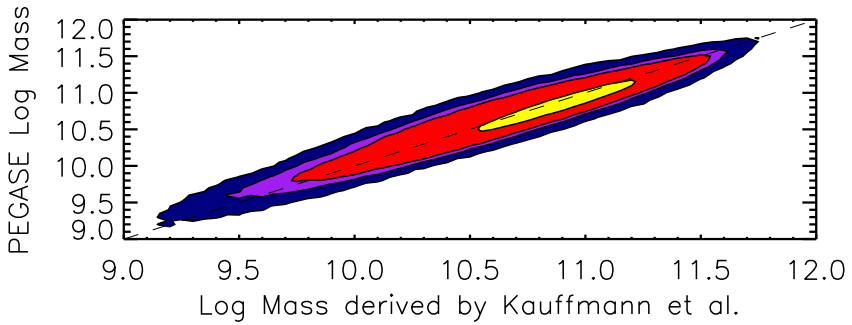


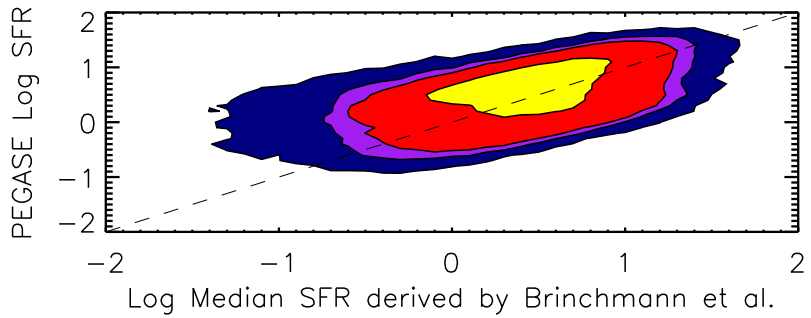
- Lampeitl et. al. 2010 also looked at cosmological consequences with both SALT2 and MLCS.
- However …. (many) tests showed that these models were not the best at estimating properties

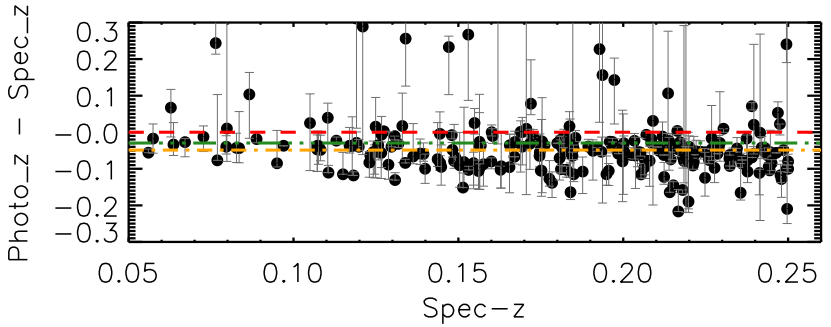
For those that missed it (3) …

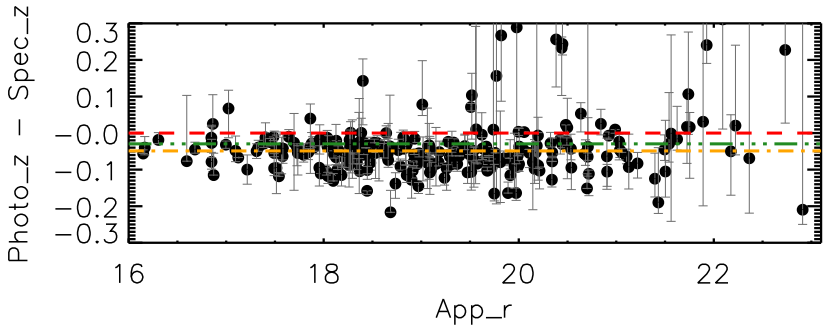
We also looked at PEGASE systematics:

- Photo-z estimates
- Comparison to measured results









- When the redshift is known PEGASE is fairly good
- However, it is not good at estimating photo-z's – there's an offset
- Does not affect the final result! (modulo one or two assumptions)

Several Possible Extensions…

- Consider the “most up-to-date” models
- Extend the analysis carried out by Hubert
- Looking for higher-order correlations in the SDSS-II dataset
- Study intrinsic dispersion as a function of environment
- Move from host galaxy mass to metallicity
- Combine both SDSS/SNLS (with Mark Sullivan)

The Maraston Models (2005)

- The PEGASE.2 models are not the most accurate models
  - They are similar to the physics of the BC03 models
  - Do not contain the TP-AGB branch of stellar evolution
- Update the analysis to the Maraston 2005 models
  - These are known to provide better redshift estimates
  - Include the ability to "estimate" metallicity (currently just using output values)
- Utilize the "hyperz" and "hyperzspec" codes

- Many different template choices available
  – However, these are not tuned to what we are considering!

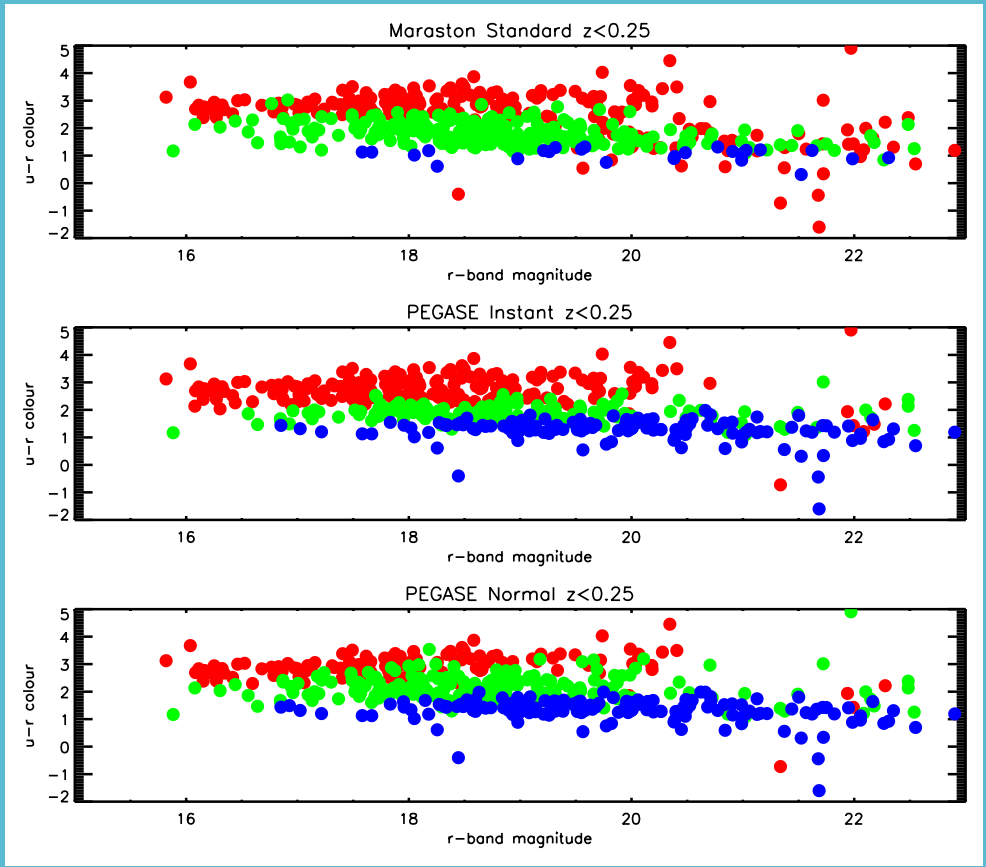
- We are currently using 32 templates each evaluated at 51 epochs (1632 possibilities)
- hyperzspec also allows the ability to consider 6 different reddening laws

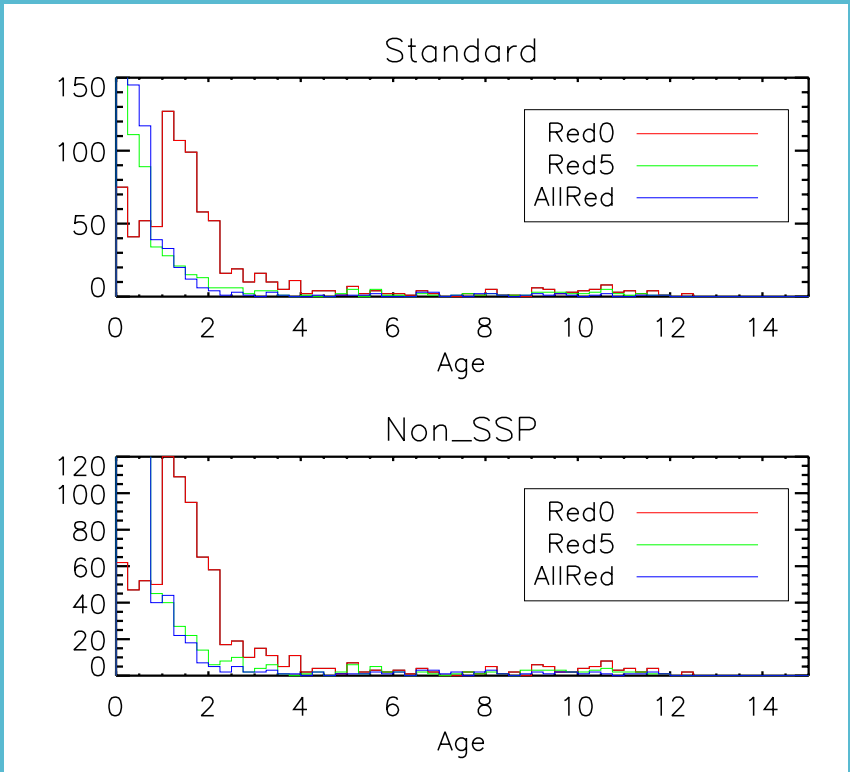
- More sophisticated templates (such as "inverse tau" models) are available – however, it is unclear if our galaxies are match these

- THERE IS A LARGE DEGENERACY IN GALAXY MODELLING – NEED TO THINK CAREFULLY

Selection Criteria

- Needs refinement!
- The degeneracy's are important
- Consider splitting by galaxy colour and then fitting separately?

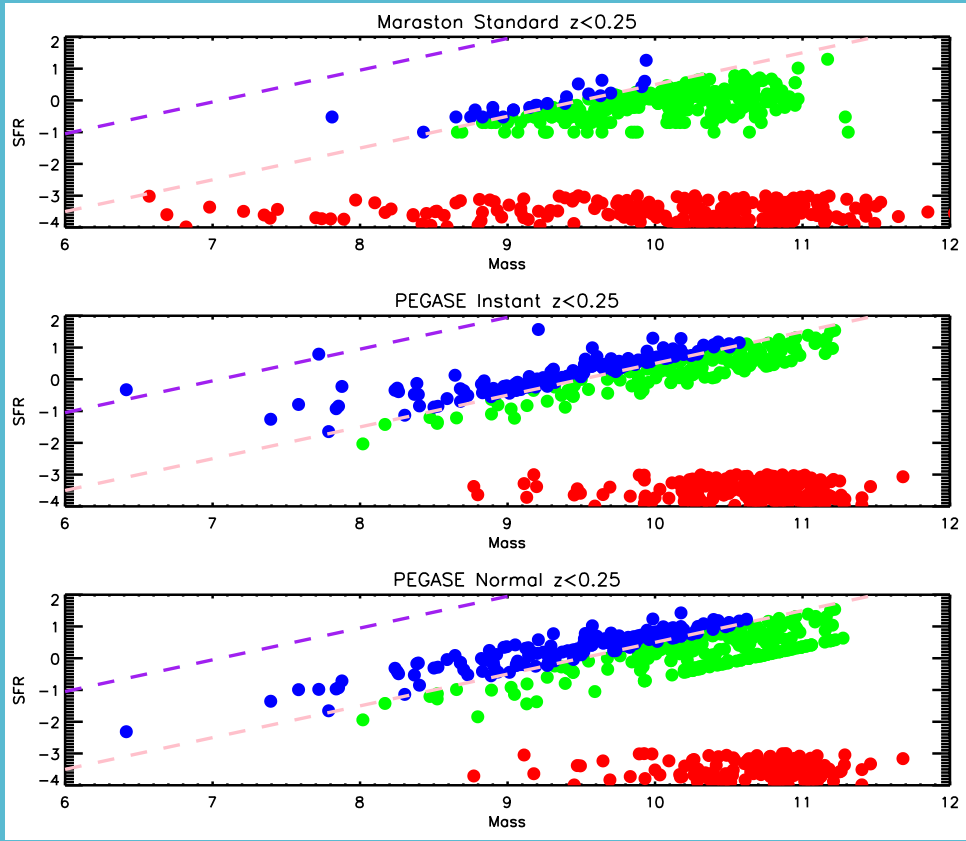


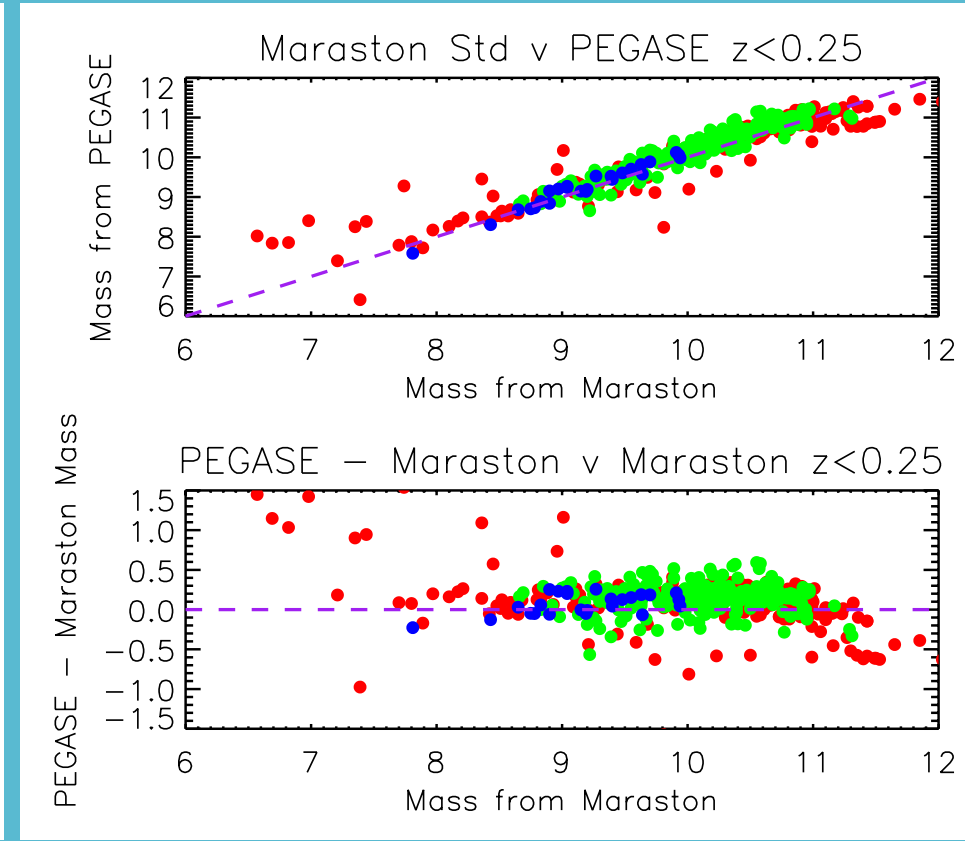


The default set-up:

- 32 standard templates (no inverse tau)
- No reddening law
- 5 color bands + redshift
- Single confidence level (joint now available)
- 4 estimates of metallicity

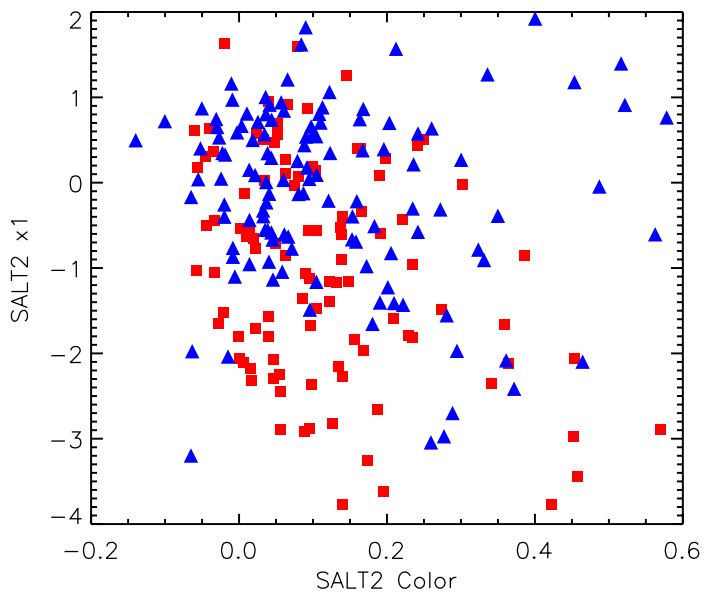
Maraston v PEGASE

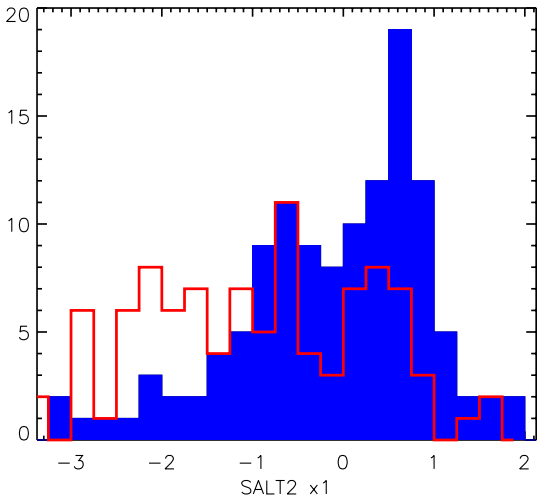


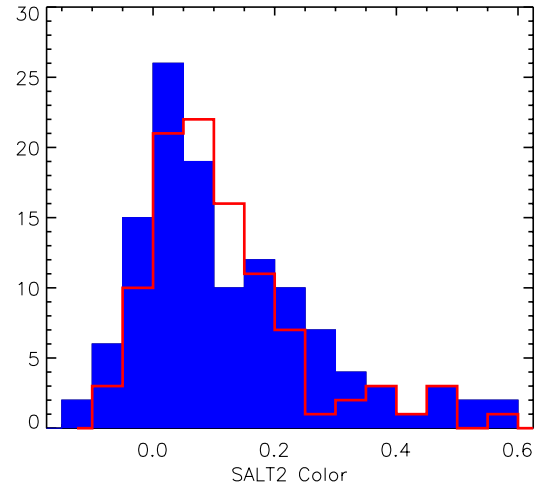


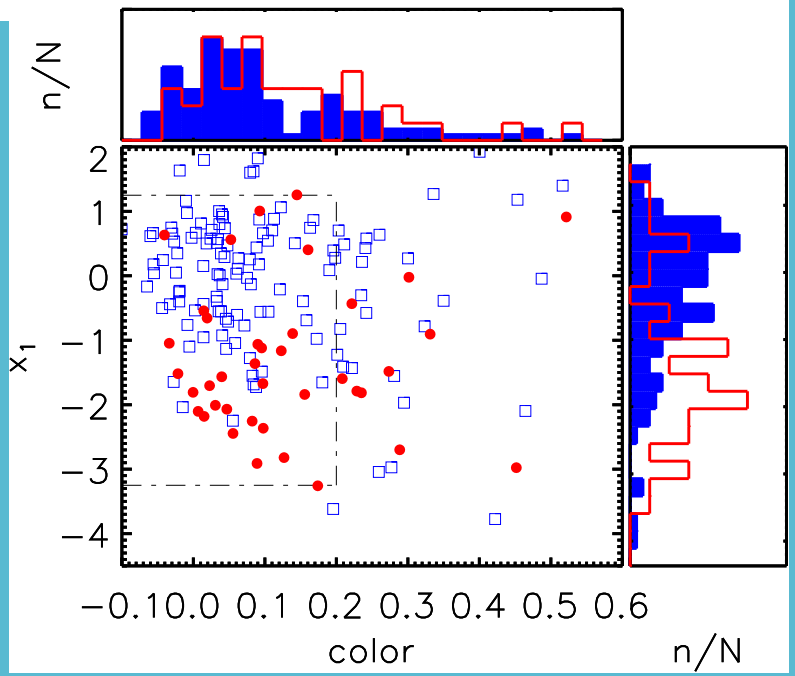
- The SFR's from Maraston are a lot lower than those from PEGASE.
  - Cannot be explained by Instantaneous SFR, maybe template / reddening choice?
- Stellar mass estimates are systematically lower
  - Maybe well known, but is not in the literature!

Now on to some supernova …



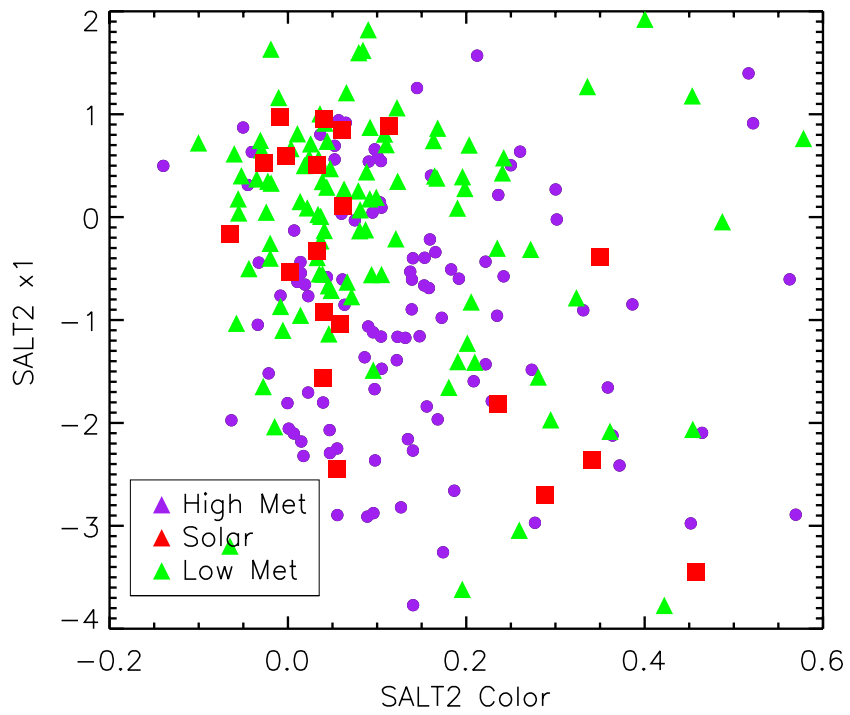


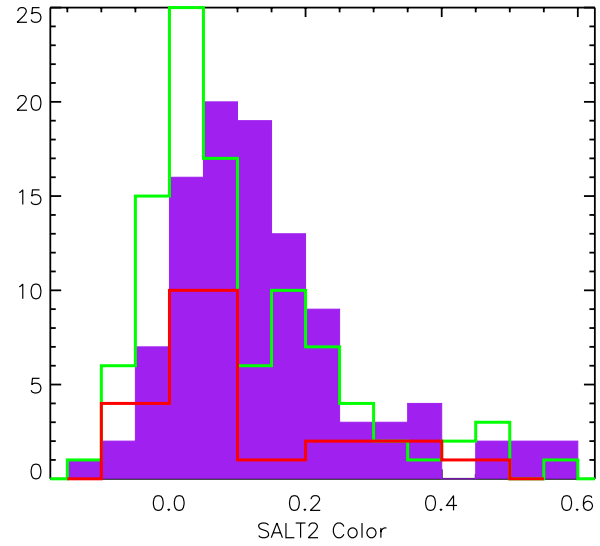


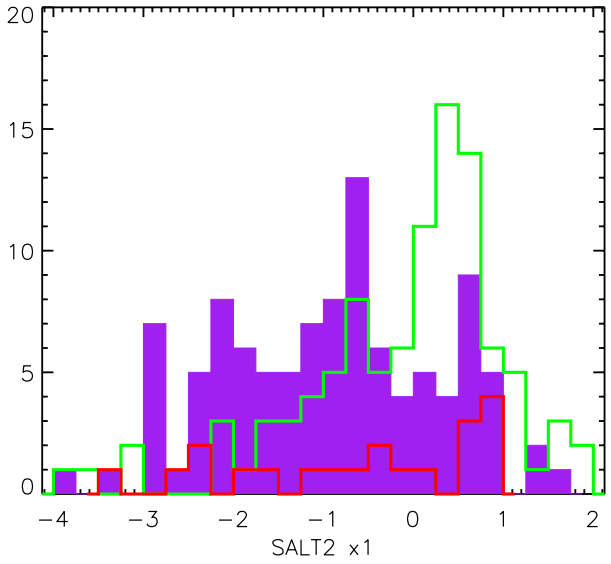


- Stick to z < 0.21, r < 23 (+ well measured lc's)
  - leaves us with 223 type 120s and 105s
- Using SALT2 - The Color distributions are the same for star-forming / passive
  - Matches Hubert
- The increased number of passive galaxies means that the x1 distribution for passives is now flat

How about Metallicity?....

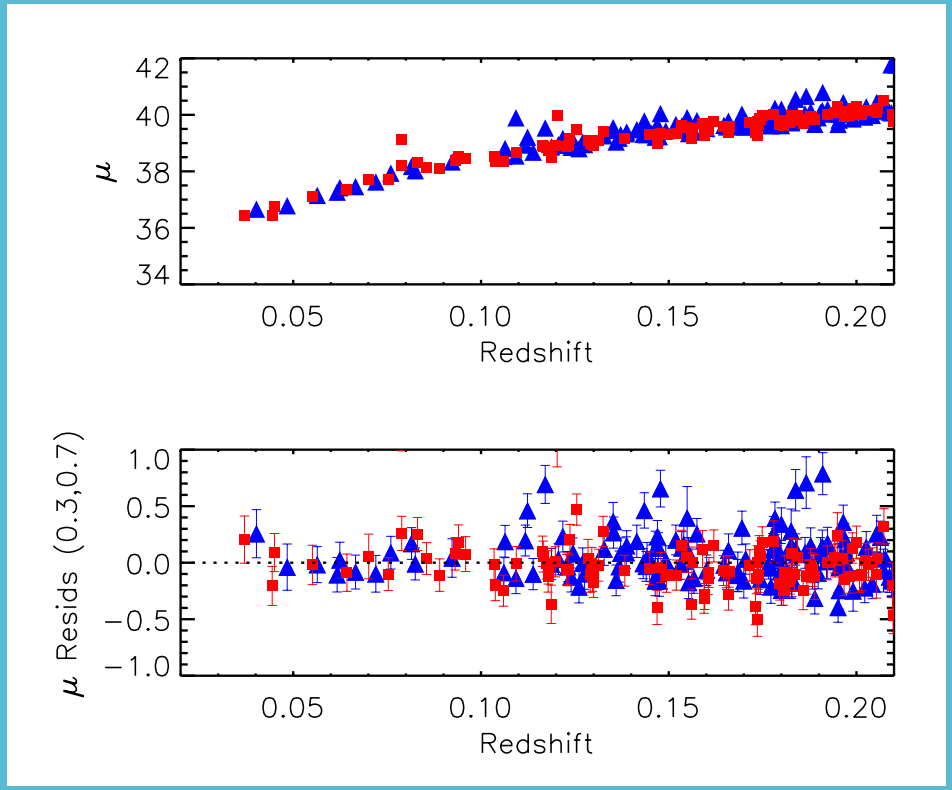


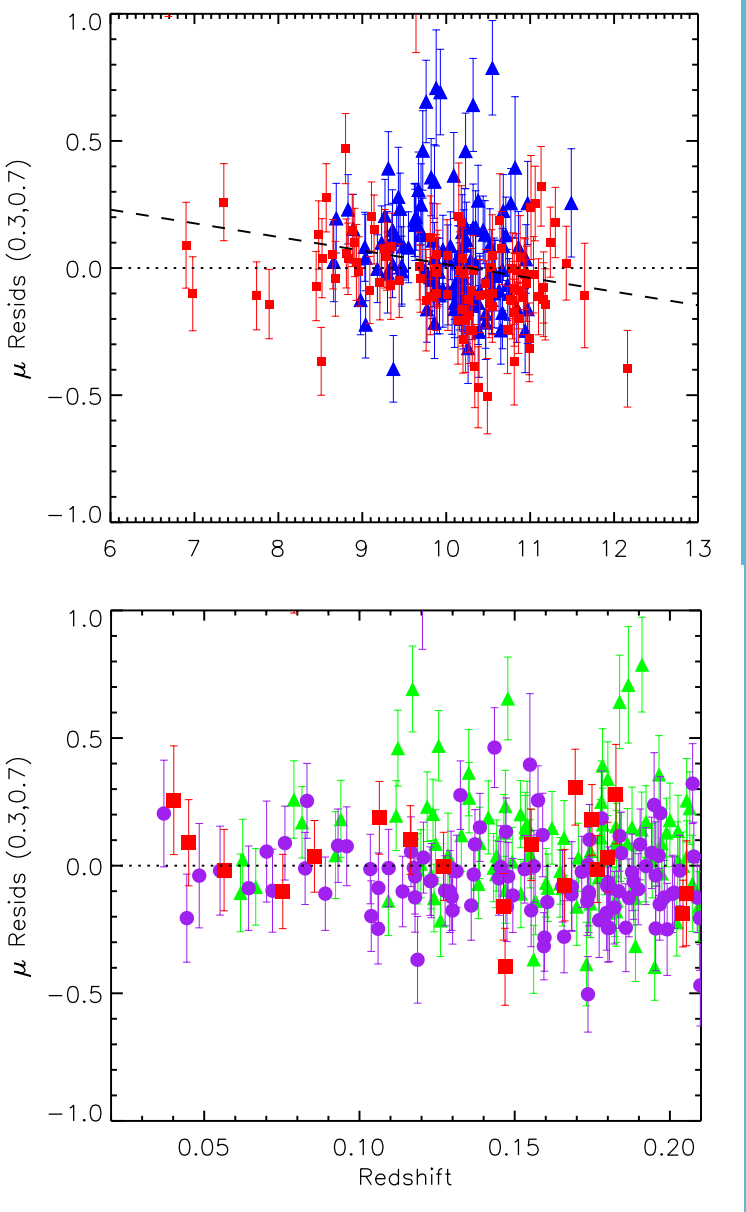




4 estimates of metallicity
-20 solar (Z=0.02), 100 low met (Z=0.01 and 0.004), 103 high met (Z=0.04)
- x1 distributions seem to match galaxy type split, “some evidence” for a different distribution of color?
- Needs cross-checking!!!!! (from spectra?)

Finally (for now), some Hubble diagrams





HIGHLY PRELIMINARY

- The absolute magnitude difference with host galaxy type is “washed out”?
- Higher correlations with mass remain?
- An offset with metallicity??
- Scatter is smaller with passives?? (Investigate)
- Need to be a lot more quantitative

Coming soon / next

Short Term:

- Get the first paper out!
- Extend to higher redshift (or at least consider it)
- Look at scatter from the Hubble diagram (tentatively, passives still show smaller scatter)
- Values of alpha, beta, m0, ….
- Considering higher order corrections to the SALT law
- A better understanding of how these values relate to spectral features / Mannucci

Shortish Term:

- Integrating with the SNLS sample
  - Datasets have been exchanged
  - Need to find a uniform way to estimate galaxy parameters
  - However calibration (modelmag to sextractor mag) seems to be an issue

Medium Term: (!)

- Looking at local galaxy density (SDSS only)
- CMAGIC
- Maybe morphological type (GalaxyZoo), underlying galaxy colours …. (too much)
- A paper (not systematics dominated!) on results with the Maraston templates (short term goal) and one combining with the SNLS sample?